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(54) **Concrete composition**

(57) A concrete composition comprises a cementitious material, a coarse aggregate, a fine aggregate and water, the cementitious material comprising an intimate mixture of from 95% to 75% by weight of Portland cement and from 5% to 25% by weight of ground calcareous rock, for example limestone, chalk, marble or dolomite, substantially all of which consists of particles smaller than 3mm.

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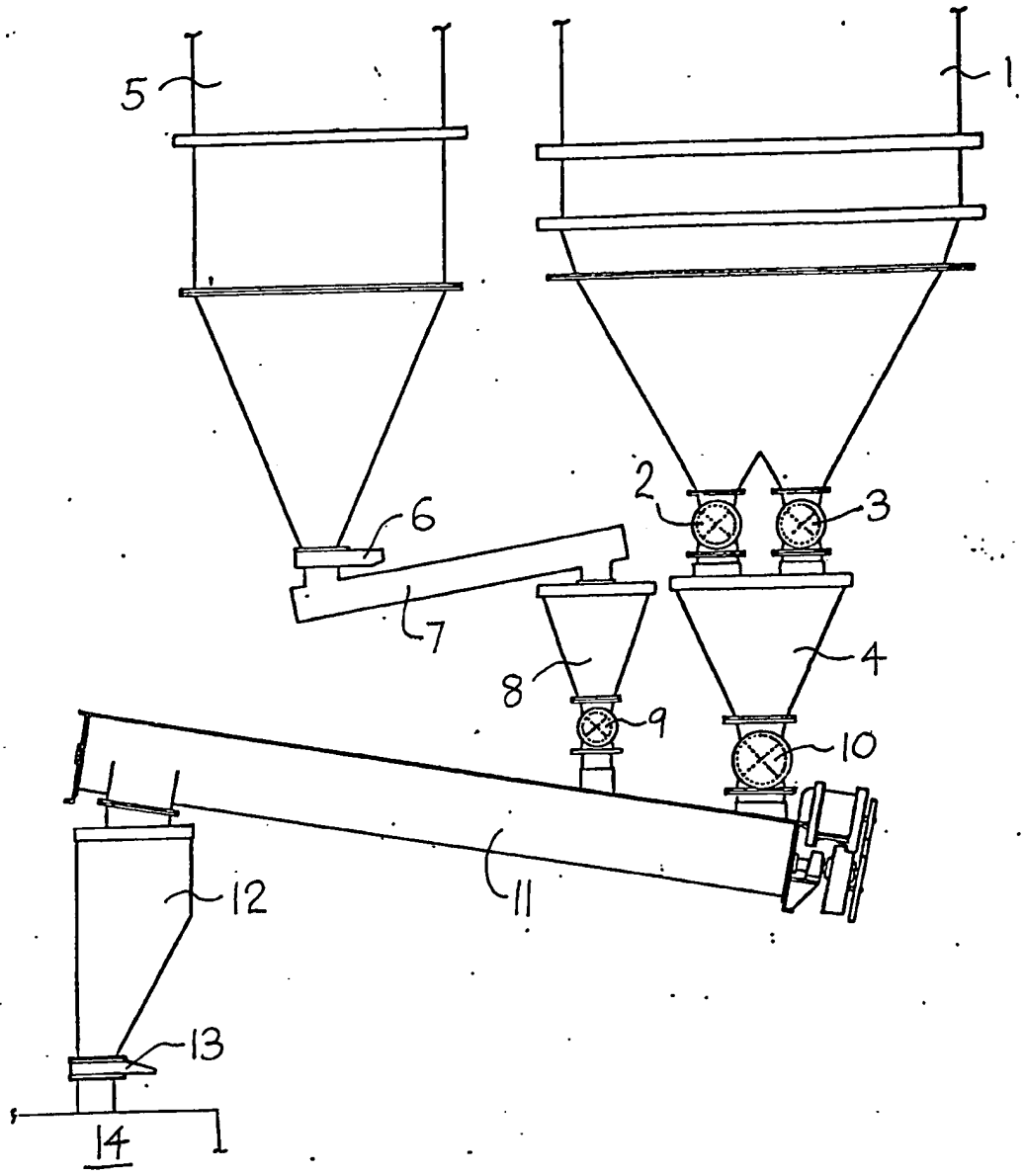
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SPECIFICATION

Concrete compositions

This invention concerns concrete compositions such as are used in the manufacture of concrete products such as building elements and in readymix concrete.

Portland cement is an expensive commodity because of the high temperatures required in its process of manufacture and hence the high consumption of thermal energy. However hitherto attempts to reduce the amount of Portland cement in a concrete composition have almost inevitably resulted in a concrete product of reduced strength.

The object of the invention is to reduce the proportion by weight of Portland cement in a concrete composition while keeping the strength of the concrete product formed therefrom substantially unchanged.

Accordingly, one aspect of the invention provides a concrete composition comprising a cementitious material, a coarse aggregate, a fine aggregate, or sand, and water wherein the cementitious material comprises an intimate mixture of from 95% to 75% by weight of Portland cement and from 5% to 25% by weight of ground calcareous rock substantially all of which consists of particles smaller than 3mm.

The calcareous rock is preferably limestone, but ground chalk, marble or dolomite may also be used.

The coarse aggregate generally consists of gravel or crushed natural rock or stone substantially all the particles of which are between 5mm and 20mm in size.

The fine aggregate complies with the specification laid down in British Standard Specification No. 882,1201:Part 2:1973 "Coarse and fine aggregates from natural sources".

The fine aggregate is composed of particles resulting from either the natural disintegration or mechanical crushing of rock, hard stone or gravel and should be free from clay, soluble sulphate salts and other deleterious matter. Substantially all of the particles are between 75 microns and 5mm in size.

The cementitious material preferably comprises an intimate mixture of from 92% to 88% by weight of Portland cement and from 8% to 12% by weight of ground calcareous rock.

Preferably substantially all of the ground calcareous rock consists of particles smaller than 2mm and from 75% to 95% by weight consists of particles smaller than 600 microns.

A second aspect of the invention provides a process for preparing a concrete composition wherein from 95% to 75% by weight of Portland cement is intimately mixed with from 5% to 25% by weight of ground calcareous rock substantially all of which consists of particles smaller than 3mm and the intimate mixture of Portland cement and ground calcareous rock is then mixed with coarse aggregate, fine aggregate and water.

In order to produce a composition which will yield concrete products having substantially the same strength as products formed from conventional compositions wherein the cementitious material is 100% by weight of Portland cement, it is necessary that the Portland cement and the ground calcareous rock are intimately mixed together before the cementitious material is mixed with the coarse and fine aggregates and water.

If it is attempted to make a modified concrete composition by adding Portland cement, ground calcareous rock, coarse and fine aggregates and water simultaneously to the same mixer the resultant composition will inevitably yield concrete products of reduced strength compared with products formed from a conventional composition containing a weight of Portland cement equal to the combined weight of Portland cement and ground calcareous rock in the modified composition.

For a better understanding of the invention, and to show more clearly how the same may be carried into effect, reference will now be made, by way of example, to the accompanying Figure which is a diagrammatic representation of a plant for carrying out the process of the invention.

Referring to the Figure, Portland cement is contained in a silo 1 whence it is discharged at a substantially uniform rate by means of two variable speed rotary valves 2 and 3 into a mass-flow hopper 4 of the type described in "Chemical Engineers' Handbook", 5th edition, by Robert H. Perry and Cecil H. Chilton, Mc.Graw-hill Book Company, New York, 1973, pages 7-28 and 7-29. Ground limestone is contained in a silo 5 and is discharged at a substantially uniform rate by means of a manually operated slide valve 6 and a screw conveyor 7 to a mass-flow hopper 8. Ground limestone and cement are fed in predetermined proportions by weight through variable speed rotary valves 9 and 10 respectively to a screw conveyor 11 which is of sufficient length and of such screw geometry as to ensure substantially complete mixing of the two materials before the mixture is discharged from the screw conveyor.

The mixture leaving the screw conveyor is contained in a hopper 12 whence it is discharged through a pneumatically operated slide valve 13 to the mixer, indicated at 14, of a concrete block manufacturing plant where it is mixed with coarse and fine aggregate and water.

The invention is further illustrated by the following Examples.

EXAMPLE 1

In a plant for manufacturing blocks, Portland cement was contained in a silo 1 and ground limestone in a silo 5. The ground limestone had a particle size distribution such that the percentages by weight passing various test sieves fell within the ranges given in Table I below:-

TABLE I

B.S. sieve mesh no.	nominal aperture (mm)	% by weight passing
7	2.36	100
14	1.18	95-100
25	0.600	80-90
52	0.300	59-79
72	0.210	55-65
100	0.150	45-61
200	0.075	35-47

Batches of concrete were prepared according to four different recipes 1A, 1B, 2A and 2B. Batches 1A and 1B were intended to produce blocks having a crushing strength of 7.0 N/mm^2 and batches 2A and 2B to produce blocks having a crushing strength of 10.5 N/mm^2, all being tested in accordance with British Standard Specification No. 2028,1364:1968 "Precast concrete blocks".

The recipes for the different batches of concrete are given in Table II below:-

TABLE II

Batch numbers	1A, 1B	2A, 2B
crushing strength (N/mm^2)	7.0	10.5
cementitious material (% by weight)	7	10
dry fine aggregate (% by weight)	36	35
dry coarse aggregate (% by weight)	57	55
weight ratio total water/cementitious material	0.65	0.46
density of concrete product (Kg/m^3)	1980	2040

The fine aggregate was crushed limestone sand which had a particle size distribution in accordance with Grading Zone 2 as given in British Standard Specification No. 882,1201: Part 2: 1973.

The coarse aggregate comprised limestone particles of sizes in the range from 3mm to 6mm.

In batches 1A and 2A the cementitious material was an intimate mixture of 90% by weight of Portland cement and 10% by weight of limestone.

In batches 1B and 2B the cementitious material was 100% by weight Portland cement.

Blocks were formed from each batch of concrete and were tested for crushing strength in accordance with British Standard Specification No. 2028,1364:1968. The results are set forth in Table III below:-

TABLE III

	Nominal crushing strength (N/mm^2)	Measured crushing strength (N/mm^2) Cementitious material: 90% Portland cement 10% ground limestone		Measured crushing strength (N/mm^2) Cementitious material: 100% Portland cement
Batch no.		1A		1B
	7.0	7.22		6.92
	"	7.67		7.20
	"	7.82		7.87
	"	6.13		6.39
	"	6.90		7.38
		7.15	average	7.15 average
Batch no.		2A		2B
	10.5	10.50		10.80
	"	10.52		10.30

Each of the figures given in Table III above represents the average crushing strength of a sample of ten blocks, and it will be seen that, within the limits of experimental accuracy, the replacement of 10% by weight of the Portland cement in batches 1B and 2B with 10% by weight of ground limestone intimately mixed with the Portland cement caused no significant decrease in the crushing strength of the blocks.

EXAMPLE 2 (comparative)

A further batch of concrete was prepared according to the same recipe as batch 2B except that the weight of Portland cement was reduced by 10% and no ground limestone was mixed therewith. The average crushing strength of a sample of ten blocks prepared from this batch of concrete was 9.33 N/mm^2.

EXAMPLE 3

Two further batches of concrete were prepared according to the same recipe as batch 1A except that in one of the batches the cementitious material consisted of an intimate mixture of 90% by weight of Portland cement and 10% by weight of ground limestone, while in the other batch the same weights of Portland cement and ground limestone were added separately to the concrete mixer together with the coarse aggregate, the fine aggregate and water. Blocks were prepared from each batch of concrete and the average crushing strength of a sample of ten blocks prepared from the batch in which the cementitious material was an intimate mixture of Portland cement and ground limestone was 7.68 N/mm^2, and the average crushing strength of a sample of ten blocks prepared from the batch of concrete in which the Portland cement and ground limestone were added separately was 7.18 N/mm^2.

CLAIMS

1. A concrete composition comprising a cementitious material, a coarse aggregate, a fine aggregate and water, wherein the cementitious material comprises an intimate mixture of from 95% to 75% by weight of Portland cement and from 5% to 25% by weight of ground calcareous rock substantially all of which consists of particles smaller than 3mm.
2. A concrete composition according to Claim 1, wherein the cementitious material comprises an intimate mixture of from 92% to 88% by weight of Portland cement and from 8% to 12% by weight of the ground calcareous rock.
3. A concrete composition according to Claim 1 or 2, wherein substantially all of the ground calcareous rock consists of particles smaller than 2mm and from 75% to 95% by weight consists of particles smaller than 600 microns.
4. A concrete composition according to Claim 1, 2 or 3, wherein the ground calcareous rock is ground limestone.
5. A process for preparing a concrete composition, wherein from 95% to 75% by weight of Portland cement is intimately mixed with from 5% to 25% by weight of ground calcareous rock substantially all of which consists of particles smaller than 3mm and the intimate mixture of Portland cement and ground calcareous rock is then mixed with coarse aggregate, fine aggregate and water.
6. A concrete composition according to Claim 1, substantially as described in the foregoing Example.
7. A process according to Claim 5, substantially as hereinbefore described.

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